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Gesture Production, Motor Skills, and Disfluencies Observed in Typically Developing Preschoolers

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GESTURE PRODUCTION, MOTOR SKILLS, AND DISFLUENCIES OBSERVED IN TYPICALLY DEVELOPING PRESCHOOLERS

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By

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ABSTRACT

GESTURE PRODUCTION, MOTOR SKILLS, AND DISFLUENCIES OBSERVED IN TYPICALLY DEVELOPING PRESCHOOLERS

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Thesis supervised by Heather Leavy Rusiewicz, Ph.D., CCC-SLP

Interest in gesture production has considerably increased in recent decades, yet few studies have examined the preschool population. Even fewer studies have examined the intriguing interaction between motor skills and gesture. The original intent of this study was to investigate the relationship of gesture and motor skills in individuals who stutter. However due to recruitment limitations the enrolled sample consists solely of typically developing preschoolers, 3:8 to 6:6 years. Data are presented on gestures and disfluencies during spontaneous speech, a cartoon narration, and a video narration. Additionally, disfluencies were observed during a procedural description task with restricted hand use and hand tapping. Data indicated that higher frequencies of gestures and disfluencies were seen during the cartoon narration. A greater frequency of disfluencies was also experienced with restricted hand use. Relationships between the variables were also explored. Limitations and implications of these results are discussed from both theoretical and clinical perspectives.

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Introduction

The purpose of this study was to investigate the motor abilities and use of gestures in preschool-aged children. Although there has been a relative surge of research on gestures in recent decades, research involving gesture production in preschool-aged children remains limited. Also lacking is research investigating whether an interaction exists between gestures and motor skills. One population which may provide more insight into a possible relationship between gestures and motor skills are individuals who stutter. This population is intriguing as previous research, though anecdotal, has indicated that people who stutter use fewer gestures than those who do not stutter. This research as well as research concerning the motor skills of those who stutter, led to the hypothesis that people who stutter may exhibit a general, though subtle, motor deficit rather than just a speech-motor deficit. The original intent of this study was to examine the motor skills, gesture use, and disfluencies of preschool-aged children, 3;0 to 6;0 years, who do and do not stutter. However, due to recruitment limitations the present sample consists solely of typically developing preschool children ages 3;8 to 6;6 years.

Gestures, Motor Skills, and Disfluencies

The three variables examined in this study include gestures, motor skills, and disfluencies. These variables were inspired by literature on stuttering, which indicated that in two studies, both adults and children who stuttered stopped mid-gesture when they experienced a disfluency. In addition, while the research is conflicting, numerous studies have shown that people who stutter have slower times on motor tasks, such as finger presses. Both of these findings raised the question as to whether people who stutter may exhibit subclinical motor deficits. In order to examine this hypothesis the study intended to look at gesture use, motor abilities, and disfluencies in preschool-aged children who stutter as compared to same age children who do not stutter. However, due to recruitment limitations data regarding preschool children who stutter were not included in this study. Before delving into the relevance of investigating gestures, motor skills, and disfluencies in preschool-aged children, background information is provided for each variable.

Gesture.

Definition of gesture. Gestures, often defined as arm and hand movements that are temporally coordinated with speech, are good examples of manual motor movements that often occur with speech and can be observed in a person's natural environment (McNeill, 1992). Gestures often occur simultaneously with speech, adding emphasis and meaning to speech. Gestures can even play a compensatory role when we encounter difficulty with expressive language (e.g., Iverson & Braddock, 2011, p.75). There are four main types of gestures: deictic, conventional, representational, and beat gestures, as described according to Iverson and Braddock (2011, p. 77). Deictic gestures are those which indicate a referent in the immediate environment by pointing to an object, person, location, etc., or by holding up an object for another person to see. Conventional gestures (i.e., emblematic) are those which contain meaning recognizable by others even in the absence of accompanying language. Examples include waving goodbye and nodding the head "yes." Representational gestures depict a characteristic of or an action performed by a referent. An example of a representational gesture would be flapping the arms to refer to a bird flying. Finally, beat gestures are formless movements of the hands and arms that follow the rhythm of accompanying language, highlighting aspects of discourse structure but conveying no semantic information. An example of a beat gesture would be flicking the hand up and down or back and forth while speaking.

Theories of gesture. While the link between gestures and speech is not completely clear, two main theories concerning the connection are presented here. The first theory is the independent hypothesis, which states that the speech system and the gesture system are completely independent communication systems (Butterworth and Beattie, 1978; Butterworth and Hadar, 1989; Feyereisen, 1997; Feyereisen and DeLannoy, 1991; Levelt, Richardson, and La Heij, 1985). This theory proposes that "gesture functions as a backup or auxiliary system for the temporary absence or failure of speech" (Mayberry, Jaques, & DeDe, 2008, p.79). According to this hypothesis, speech needs to fail in order for gestures to appear in the communication system. A second theory proposes that speech and gesture form an integrated communication system "for the single purpose of linguistic expression" (Kendon, 1980; Mayberry& Jaques, 2000, p.200; McNeill, 1985, 1992). In this theory, "gesture is linked to the structure, meaning, and timing of spoken language" (Mayberry & Jaques, 2000, p.200). According to this integrated theory, speech and gesture are postulated to be co-expressed at all points within spoken language processing. If this theory is correct, gestures would almost always be expressed with speech and would add meaning to the spoken language rather than replacing it as the first theory states.

Gesture use in typically developing children. McNeill (1992) stated that "gesture and speech emerge together," which implies "that a linkage of gesture and speech exist from an early stage" (p.295). This link can be seen in the earliest stages of language learning (Goldin-Meadow, 2003) however, the exact connection of language and gestures as well as the typical development of gestures is still relatively unknown. Likewise, the majority of empirical assessment of gesture production in children studied early gesture use by infants and toddlers and to a much lesser extent, preschool aged children in the midst of tremendous speech and language growth.

As seen in Table 1, gesture use in children begins around ten months, when children express interest in objects by pointing, holding an object up for someone to see, or reaching for an object (Capone & McGregor, 2004; Goldin-Meadow, 2003). Goldin-Meadow (2003) stated that "gesture may reflect the child's interest in learning the name of an object or may be paving the way for the child to learn the name" (p.210). The development of iconic gestures, those which capture aspects on its intended referent, are believed to begin before the child's vocabulary reaches 25 words (Capone & McGregor, 2004; Goldin-Meadow, 2003; McNeill, 1992). Around 20 months of age children begin to use "empty handed gestures" to depict the function of objects (Capone & McGregor, 2004). Research concerning beat gestures is mainly anecdotal without consensus as to when they develop. For instance, Capone and McGregor (2004) stated that beat gestures begin around 20 months of age, McNeill (1992) stated that these gestures begin sometime between three and five years old, while Nicoladis, Mayberry, and Genesee (1999) stated simply that beat gestures develop as the child's language develops. Even though it is unknown exactly when beat gestures begin it is accepted that beat gestures begin later than other types of gestures because they are linked to prosody and discourse and are a more complex type of gesture despite their simplistic form.

Table 1
Gestural, Speech, and Linguistic Milestones.

Age	Gesture
8-10 months	deictic
12-18 months (25 words)	*lexical*- iconic (representational)
20 months	"empty handed gestures" Beat gestures (Capone & McGregor, 2004)
36 months and beyond (McNeill, 1992)	Beat gestures
Through adolescence (McNeill, 1992)	Abstract pointing, metaphors

Based on Capone & McGregor, 2004; Goldin-Meadow, 2003; and McNeill, 1992)

The frequency of gestures seems to increase as children develop according to Colleta, Pellenq, and Guidetti (2010). These investigators examined the gesture use of 84 French speaking children, ages six and ten compared to the gesture use of 38 French speaking adults. In this study, the participants watched a wordless *Tom and Jerry* cartoon and then were asked to retell the story. While retelling the story the adults gestured significantly more than the ten year olds, and the ten year olds gestured significantly more than the six year olds (p.572). Thus an increased use of gestures was observed with age. Colleta et al. then analyzed the types of gestures used by each age group. Due to the nature of the narration, deictic gestures were removed from analysis. The types of gestures that were focused on were representational (represents an object or property of that object), framing (occurred during the telling of an event and expressed the speaker's emotional or mental state), and discursive gestures (where a generally brief gesture e.g. beat, helped to structure speech and discourse) (p.569). Each group used more representational gestures over the other two types of gestures. Both the six year old group as well as the ten year old group used discursive (beat) gestures the least of all types of gestures. This was compared to the adults who used discursive (beat) gestures as their second most frequently used gesture type. Thus a "greater increase in non-representational gestures than in representational ones was seen with an increase in age" (p. 574). This supports McNeill's (1992) claim that the development of gestures begins with the denoting of concrete objects then moves to iconic gestures and finally beat gestures. As the amount of research concerning gesture use in typical children is lacking it is important to look at gestures in other pediatric populations such as children with language impairment.

Gesture use in children with language impairment. Iverson and Braddock (2011) examined the gesture production of children with language impairment between the ages of 2;7 to 6;1 years as compared to their same-age peers. The children were observed during two narration tasks, a cartoon narration adapted from the Autism Diagnostic Observation Schedule (ADOS) (Lord, Rutter, DiLavore, & Risi, 1999) and a book narration using the wordless picture book Frog, Where are you? (Mayer, 1980), both of which they completed with their caregiver (Iverson & Braddock, 2011, p.76). The authors found that children with language impairment gestured at a rate nearly one and a half times that of their typical same age peers on average (Iverson & Braddock, 2011, p.78). Children with language impairment also produced a higher proportion of conventional gestures, those which contain recognizable meaning in the absence of speech, than their same age peers (Iverson & Braddock, 2011, p.83). This observation led to the hypothesis that these gestures "may be a more efficient means of communication for whom speech is effortful and relatively unintelligible," since they can be understood in the absence of accompanying speech (Iverson & Braddock, 2011, p.83). Therefore it is believed that since the children with language impairment often had difficulty obtaining a word, it was less of a demand on their cognitive resources to use a gesture instead as a compensatory strategy in order to be understood (Iverson & Braddock, 2011).

The children with language impairment also "lagged significantly behind their typically developing age-mates in both fine and gross motor skills" (Iverson & Braddock, 2011, p.81). This finding adds to a growing body of work "indicating that motor and language systems are closely linked in the brain from very early in development and that when language is impaired, some level of motor difficulty is generally apparent" (Bates & Dick, 2002; Iverson & Braddock, 2011, p.81; Iverson & Thelen, 1999). Interestingly though the children with language impairment demonstrated deficits in their fine and gross motor abilities, but gestured with a higher frequency as compared to the typically developing participants.

To date, only two other studies investigating the relationship between language impairment and gesture production were completed. First, Evans, Alibali, and McNeil (2001) instructed seven to nine year old children with specific language impairment (SLI) and typically developing peers to reason through a series of Piagetian conservation tasks. The participants with SLI conveyed information in gesture that was not present in oral language with twice the frequency of their same age peers without SLI (Iverson & Braddock, 2011, p.74). Second, Blake, Myszczyszyn, Jokel, and Bebiroglu (2008) examined five to ten year old children with SLI and typically developing peers during a cartoon narration and descriptive narration. The children with SLI produced more iconic gestures overall. They also used these gestures in replacement of words more than their age and language matched peers. These observations led to the conclusion that children with language impairment tend to use more gestures than typically developing children because gestures help them to get their point across when their language fails them. This is noticeable different from gesture use in people who stutter as gestures do not appear to assist this population with getting their point across when their language fails them. Instead their gestures appear to stop when experiencing a disfluency, only to continue when their fluency returns. Because the original impetus of this project was to explore the gesture production and motor skills of preschoolers with and without fluency disorders, literature and information regarding stuttering and particularly the gesture and motor processes of individuals who stutter are also presented.

Gesture in adults and children who stutter. To date, the only study that investigated gesture use in those who stutter was completed by Mayberry, Jaques, and DeDe (1998). Mayberry et al. observed 12 adults, ages 21 to 51 years, six who stuttered and six typical speakers, while they narrated an animated cartoon. Each subject was given unlimited time to narrate the cartoon but it was found that there was "a strong effect of stuttering on the length, complexity, and content of the subjects' spoken narrative" (p.81). The typical speakers used more words in less time (35% more words in 50% less time) as compared to the subjects who stuttered. In addition to using fewer words, those who stuttered also used less complex sentences and provided less detail for their narrations. In respect to gestures, it was seen that those who stuttered produced half the number of gestures that the typical speakers used. Mayberry et al. (1998) found that “the fluent controls accompanied 78% of their spoken words with gestures, whereas the subjects who stuttered accompanied only 30% of their words with gestures” (p.81). In other words, those who stuttered used significantly less gestures in their speech than their typical peers.

Mayberry, Jaques, and DeDe (1998) also noted when gestures were used by both groups of subjects. They observed that whether or not a gesture was used during typical disfluencies, was equal in both groups. The authors concluded that these typical disfluencies do not have much impact on gestures. However, stuttering-like or atypical disfluencies were rarely accompanied by gesture (p.82). If a gesture was being produced when a stuttering-like disfluency occurred, “the gesturing hand would fall to rest or remain frozen in air during the moment of stuttering and then rise again, resuming production of the abandoned gesture within milliseconds of the resumption of speech fluency” (p.82). Mayberry et al. (1998) concluded that “the robust correspondence between fluent speech production and maintenance of gesture production demonstrates clearly that gesture and speech are not independent systems in spontaneous expression” (p.83). This observation supports the theory that the speech-motor system and the general motor system are in fact integrated. Mayberry and colleagues (1998) also completed a similar study of the speech-gesture relationship, but this time with children during a cartoon-retelling task. This study consisted of four eleven-year old boys, two who stuttered and two with typical speech, and is the only study to look at gesture use in children who stutter. All children used fewer gestures than the adults to accompany their spoken language but the controls once again used more gestures than those who stuttered (controls 26% of speech was accompanied by gestures whereas only 8% of the speech of those who stuttered was accompanied by gestures) (p.82). The children also did not use gestures to compensate for their speech difficulties but rather their gestures stopped anytime they experienced a stuttering-like disfluency. These data, though exploratory, indicate that not only is there much more to learn about gesture production in children developing speech typically, but certainly also much more to investigate in regards to gesture production in disordered pediatric populations, particularly young children with fluency disorders.

Based on the findings stated above, specifically that adults used more gesture than children, Mayberry and others (1998) concluded that speaking spontaneously requires more cognitive effort for children than for adults and that gesture only appears in spontaneous speech when there are significant cognitive resources available (p.85). They also concluded that "gesture is always temporally co-expressed with speech," even when stuttering causes major disruptions to speech (p.85). The data and observations in these studies provide a lot of possible evidence into speech and gesture being an integrated system rather than independent systems. The authors strengthened their point with the following rationale:

> Based on our findings we hypothesize that the frequency with which gesture appears in the speech stream may be indicative of how many attentional resources are required to plan and produce the spoken portion of the message. When the spoken portion of the message takes most of the available attentional capacity, little capacity remains for the gestural portion of the linguistic message to be expressed (p.85).

Since it was those participants who stuttered that produced the fewest number of gestures, could this be evidence of another link to the motor system? As the original intent of this study was to examine gestures, motor skills, and disfluencies, it is important to understand that a motor deficit could be correlated with increased disfluencies as well as decreased use of gestures. To examine these questions further we look at numerous studies that examined the motor skills of both adults and children who stutter. Such studies consistently indicated evidence of differences in measures of speed, accuracy, and timing of manual movements. These intriguing findings, particularly within the developing system, point to the need for continued investigation as well as integration with more natural, spontaneous, and meaningful manual movements like gestures.

What is Stuttering?

Stuttering is a speech-motor disorder which is traditionally viewed as “a disorder in which the ‘rhythm’ or fluency of speech is impaired by interruptions, or blockages” (Bloodstein & Ratner, 2008, p. 1). The “rhythm” of speech is interrupted when the person experiences a disfluency, which is not typical of fluent speakers and has an unknown cause. While everyone experiences typical disfluencies (when word production is left intact) at times in their speech (i.e. polysyllabic word repetition, phrase repetition, interjection, revision-incomplete phrase) those who stutter also experience many atypical disfluencies (disfluencies that break up word production) or “stuttering-like disfluencies” (i.e. part word repetition, single-syllable word repetition, disrhythmic phonation, tense pause) in their speech (see Appendix A) (Bloodstein & Ratner, 2008, p.5; Guitar, 2006, p.140-142; Mayberry, Jaques, & DeDe, 1998, p.78). These atypical disfluencies are usually first observed in speech between the ages of two and four years old and may continue into adulthood (Bloodstein & Ratner, 2008, p.40).

Speech-motor system. Many posit that the underlying mechanism of stuttering lies within the speech motor system (e.g. Alfonso, 1991; Caruso, Abbs, & Gracco, 1988; Caruso, Max, & McClowry, 1999; Smith et al., 1993; Zimmermnn, 1980). Though there are different theoretical accounts of the precise role that the motor systems play in stuttering, the planning of movements is often cited as the point of breakdown. Olander, Smith, and Zelaznik (2010) describe this breakdown as follows:

> During the disfluencies that characterized stuttering, the speech motor system fails to generate and/or send the motor commands to muscles that are necessary for fluent speech to continue. Thus, disfluent intervals of speech in children and adults who stutter are clearly associated with breakdowns in the precise spatial and temporal control of movement necessary for fluent speech production (p.876).

In other words, it is hypothesized that when this plan is not sent or produced, the muscles involved in speech will have difficulty with the fluid execution of speech related movements. This is due to the deficient specifications of the timing and spatial parameters of movement within the motor plan.

Though there are multiple cortical and subcortical structures involved in speech-motor processing, a primary region is Broca's area (Olander, Smith, & Zelaznik, 2010, p.877). Importantly, this area of the brain has also been seen to control other motor behavior, such as complex hand movements (Binkofski & Buccino, 2004; Olander, Smith, & Zelaznik, 2010, p.877). These shared neuroanatomical substrates along with the known synergies across motor systems led some researchers to hypothesize that stuttering it not only a speech-motor problem but that those who stutter may also have a general motor system deficit (Max, Caruso, & Gracco, 2003; Webster, 1985; Zelaznik, Smith, Franz, & Ho, 1997) Since it is hypothesized that the speech-motor system and general motor system may be more closely connected than previously thought, it is important to look at the manual motor movements of people who stutter while they speak. One way this will be accomplished, as mentioned earlier, is by examining gesture production during speech in addition to the typical assessment of fine and gross motor skills.

Motor skills of adults who stutter. The motor skills of adults who stutter is a popular topic in the stuttering literature, though the results have been inconsistent. Most often, researchers investigated the manual reaction time of those who stutter using a simple finger press, a simple movement that can be completed without complex instructions. These studies required the participants to complete a finger press after hearing or seeing a stimulus, yet yielded disparate results. Many of these investigations demonstrated that those who stuttered took a longer time to press the switch, thus giving them a slower reaction time (Cross, 1978; Cross & Luper, 1983; Hand & Haynes, 1983; Jones et al., 2002; Reich, Till, & Goldsmith, 1981; Starkweather, Franklin, & Smigo, 1984; Webster & Ryan, 1991; Wilkins, Webster, & Morgan, 1984). Other researchers found no difference in the reaction time of those who stuttered (Hurford & Webster, 1985; Prosek, Montgomery, Walden, & Schwartz, 1979). Despite these conflicting results, a number of researchers "hypothesize that people who stutter have a general motor deficit or, in some accounts, more specifically, a timing deficit that contributes to the development and maintenance of the disorder" (Olander, Smith, & Zelaznik, 2010, p. 877).

The question of the importance of task complexity is often raised as a possible reason why previous results concerning adults have been so varied (Olander et al., 2010). For instance, a task as simple as a finger press may not be enough to tax the motor system in adults who stutter. Likewise, Olander, Smith, and Zelaznik (2010) indicated that it is possible that differences in motor abilities in people who stutter may only be seen when a task is more demanding and thus putting more stress on their system. Furthermore, observing the manual motor abilities of children who are close to the onset of stuttering and still unaware that their speech is different from their peers may make it easier to observe such a deficit, if one truly exists.

Motor skills of children who stutter. Cross and Luper (1983) were the first in recent times to examine the manual motor movements in children who stutter. The researchers were specifically looking for a relationship between finger reaction time and voice reaction time in children who stutter relative to children who did not stutter. Participants included a total of 54 children, 27 who stuttered and 27 who did not stutter, each divided equally into three ages levels: five years, nine years, and eighteen years and above. The participants were presented with a series of 21 tones at 1000 Hz of one second duration and instructed to indicate, as quickly as possible, when they heard the tone. They indicated hearing the tones by depressing a button in the finger reaction time test, or by vocalization in the voice reaction time test. Intervals between the tones were varied so as not to set a pattern for the participant to respond.

Cross and Luper (1983) found that finger reaction times were significantly longer in all age groups for participants who stuttered and that greater intersubject variability was also seen in those who stuttered (p. 358). These results are consistent with previous research in this area and thus support the idea “that atypical motor response behavior for at least some stutterers may be present during early speech motor and language development” (p. 359). The researchers indicated that there may in fact be some difference in the motor abilities of those who stutter but they also indicated that this data cannot alone support a cause-effect relationship between motor abilities and stuttering (p.

360). Bishop, Williams, and Cooper (1991) took this idea one step further by looking at the influence of task complexity on the motor performance of children who stutter. A total of 40 individual participants, 20 participants who stuttered and 20 who did not, were divided into four age groups ranging from 3;0-10;11 years. All the participants were Caucasian boys and did not receive any special academic or speech services other than those received for stuttering. Before beginning the study, the children each received a rating of mild, moderate, or severe stuttering based on the *Stuttering Severity Instrument for Children and Adults* (Riley, 1981).

Each child was asked to perform both manual and vocal tasks. The manual task included three tasks of increasing complexity: a simple finger-lift response, a finger lift followed by a finger press, and a finger lift followed by a touch and a press. The vocal task also included three tasks of increasing complexity: production of "a" in isolation, production of the words "a cow," and production of "a cowboy." Using the Lafayette Reaction/Movement Time apparatus, each participant was instructed to engage in the motor task as quickly as possible when the stimulus light was turned on. Reaction times for the manual and vocal tasks were recorded in milliseconds and the order of task complexity was randomized.

Bishop et al. (1991) found that participants who stuttered had a slower reaction time than those who did not stutter, which affirmed the results of Cross and Luper (1983) discussed earlier. Bishop et al. also found that the difference in reaction time increased with task complexity, but that this only occurred for those who stuttered (p. 215). This finding confirmed the idea stated by Olander et al. (2010) that "differences in nonspeech motor coordination and timing as well as differences in speech movement variability are more obvious in people who stutter when the task is more demanding" (p. 877). The fact that task complexity increased the manual and vocal reaction time of the participants who stutter, but not of those who did not stutter, led Bishop and colleagues (1991) to conclude that "a more generalized effect of task complexity on sensory-motor and motor-control processes," were seen in those who stutter (p. 215). Not only was reaction time increased in those who stutter, but increased variability was also seen within the reaction times. The youngest subject group demonstrated the most variability while performing the most complex verbal task. This data seems to support the theory that those who stutter have a "predisposition toward slower sensorimotor performance that is common to both vocal and manual systems and that the differences in performance between stutterers and nonstutterers are more apparent at an early age" (p. 216). This predisposition is one benefit of examining children in the early stages of stuttering when looking for evidence of a general motor deficit rather than in adults who have stuttered all their lives and who have most likely learned to compensate for some of these difficulties.

The final point made by Bishop and colleagues (1991) was that "although stutterers always had slower reaction times than nonstutterers, changes in vocal and manual reaction times followed a parallel course of improvement/development for both groups of children" (p. 215). In other words, neither group of children developed more quickly than the other but rather each followed a similar course of development for improvement in both manual and vocal tasks. This led the authors to the conclusion "that speech and manual motor movements are not independent, unrelated functions of the motor-control system at least as far as development is concerned" (p. 215). In the conclusion of their study, Bishop et al. (1991) proposed "that if the information-processing demands of a given task are within the capacity of the system, it is likely that the system will be more consistent in repeatedly producing that same or similar response" (p. 215). These researchers hypothesized that these demands may account for less variability in reaction times of those who do not have a fluency disorder as well as older children or adults with fluency disorders. These data and postulations once again are aligned with the hypothesis that the underlying mechanism and deficits associated with stuttering are likely not restricted to speech.

Building from their previous study, Williams and Bishop (1992) decided to look further into the manual movements of children who stutter, specifically those manual movements of increasing complexity. Children with articulation disorders were also included in this study as they too have been seen to have slower reaction times on vocal and manual motor tasks (p. 192). The purpose of this study was "to examine the efficiency (speed and consistency) of motor control processes involved in performance of simple manual tasks" to determine if disfluencies in speech are only one of the manifestations of stuttering (p. 193). In other words, the authors were interested in finding out if stuttering is manifested in other motor systems.

Williams and Bishop (1992) enrolled 54 Caucasian males, 18 who stuttered, 18 with an articulation disorder, and 18 with normal speech, who were equally divided into three age groups: (5;0-6;11, 7;0-8;11, and 9;0-10;11 years). All children with speech disorders were receiving therapy for speech but did not receive any other special services. As in their previous study, the authors rated each child who stuttered as mild, moderate or severe according to *Riley's Stuttering Severity Instrument for Children and Adults* (Riley, 1980). Children with articulation disorders had at least one, but no more than five articulation errors, so as to eliminate children with phonological processing disorders.

Williams et al. (1992) included a simple manual task that had two levels of increasing complexity. Both tasks involved depressing two telegraph keys, with the first task being described as a lift-press and the second task a lift-touch-press. As in the previous study, the children were instructed to complete the manual task as quickly as possible when they saw the green stimulus light illuminate. The authors measured mean movement time or speed of movement execution and standard deviation of movement time or intra-individual variability. Results indicated that the speed with which each manual movement was completed increased with age across all groups. In other words, children who stuttered, those with articulation disorders, and those with normal speech were able to complete all tasks faster as they got older. Speed of task completion decreased for all ages and groups with increased task complexity. Out of the three groups of children, those who stuttered required more time to complete the manual movements. The children with articulation disorders were noted to be significantly slower than children without communication disorders but still faster than those who stuttered.

Movement times were more variable as the task got more complex for the children with articulation disorders and the typically developing children. However, the children who stuttered demonstrated just as much variability of their movements in the simple task as in the complex task. These results indicate that both groups of children with speech disorders, those with articulation disorders, and those who stuttered, needed more time to plan and execute the motor movement, especially with the more complex task. This may indicate that children with motor-speech disorders have more general problems with their overall motor system rather than just their speech motor system. Overall those who stuttered were seen to be slower and more variable completing tasks possibly indicating that their motor execution is not as efficient as those with normal speech.

Lastly and most recently, Olander, Smith, and Zelaznik (2010) investigated the possible motor timing deficits in young children who stutter. They specifically looked at between- hands coordination and variability of rhythmic motor timing during a clapping task. The participants included 17 children, ages 4;0 to 6;0 years with a fluency disorder and 13 age-matched controls. Only children who produced three or more disfluencies for every 100 syllables in two spontaneous language samples were included.

The participants were instructed to clap along with the beat produced by a metronome and continue clapping even when the metronome stopped. Each participant had infrared emitting diodes (IREDs) attached to the distal end of their middle finger on each hand and sat in the view of a camera so the entire clapping motion could be recorded. Olander et al. (2010) hypothesized that the children who stuttered would have slower motor timing and more problems with coordination during the task.

Olander et al. (2010) found no significant difference between the interclap intervals of the children who stuttered and those who did not. However, ten of the seventeen children who stuttered showed higher clapping variability than the most variable nonstuttering child (p.881-882) indicating that "the children who stutter clearly did not maintain a consistent rate of clapping as well as normally fluent children" (p. 883). Such variability may indicate a deficit in timing as the children were not able to maintain a certain pace within the task. It was also seen that "children who stutter, on average, did not show higher levels of dyssynchrony in coordinating the movements of the two hands towards the midline" (p.882). Olander et al. (2010) concluded that these findings give strong support to the idea that a general motor timing deficit is one factor that contributes to the abnormal speech and nonspeech motor output observed in a significant portion of individuals who stutter (p.883).

Summary. As we have seen, there have been various paradigms (e.g. finger presses, clapping, formal assessments, etc) employed to investigate the manual motor system of children who stutter. Gestures are also a way to potentially assess not only at the coordination of those using the gestures, but also the connection between the speech-motor system and the general motor system in communication. These two measurements work well together in providing a more complete view of the motor systems, as well as how they interact during communication. Despite the original intent of the present study to investigate the characteristics, specifically motor skills and gesture use of preschool children who stutter compared to their same age peers with typical speech, the data presented are solely based on typically developing preschoolers.

Predictions

The initial predictions of the study are presented below. However, it is important to note that only those relating to typically developing participants are addressed.

1) Preschoolers who stutter will use fewer gestures compared to their same-age peers during spontaneous speech, cartoon narration, and video narration tasks.

2) Children who stutter will exhibit more motor deficits on the *Battelle Developmental Inventory-2 and Child Development Inventory* relative to their same-age peers.

3) Children who stutter will experience more disfluencies when encouraged to use their hands while sharing a personal narrative.

4) Children who stutter will experience fewer disfluencies when they are not using their hands (as in gestures) as well as during the hand tapping task while sharing a personal narrative.

5) Children who do not stutter will experience more disfluencies when they are not using their hands (as in gestures) as well as during the hand tapping task, and fewer disfluencies when they are encouraged to use their hands while sharing a personal narrative.

6) Throughout the three conditions, children who stutter will experience more disfluencies relative to their same-age peers**.**

Method

The study employed a within-groups combined (experimental-descriptive) design. The experimental portion examined the effect of task on frequency of gestures and disfluencies. In addition, the effect of hand use during procedural narration tasks on disfluencies was investigated. The descriptive portion examined the relationship between gesture, motor skills, and disfluencies.

Participants

Participants were nine typically developing children without a fluency disorder, ages 3;8 years (46 months) to 6;6 years (80 months) (M = 61.78, SD = 12.81, Range = 46 to 84 months). Three males and six females participated in the study. Refer to Table 2 for age and gender breakdown.

Table 2.
Participant Age and Sex

Participant Number	sex	age in months
001	M	64
002	M	48
003	F	47
004	F	80
005	F	64
006	F	79
007	M	46
008	F	66
009	F	62

Children were recruited with flyers explaining the study, posted at Children's Hospital locations and Duquesne University Speech-Language-Hearing Clinic. Participants were also recruited by word of mouth and flyers sent to early intervention programs, preschools, and daycares around the Pittsburgh area. All participants spoke standard American English as their first language. Despite concerted efforts, recruitment failed to enroll any children who stutter.

All participants were screened before being enrolled in the study through a phone interview with the parent/caregiver (See Appendix A). Potential participants were disqualified from the study if there were any indications of neuromotor, hearing, speech sound and/or language deficits. After meeting all qualifications for the study and completing the informed consent procedures, as approved by the Duquesne University Institutional Review Board, each participant attended two individual sessions at the Duquesne University Speech-Language-Hearing Clinic to complete the study. The parent consented for their minor child, as well as themselves, to permit videotaping and recording of historical information. The preschool-aged participants also engaged in an informal assent procedure consisting of the clinician describing the methodology in age-appropriate language and having the child indicate their assent verbally or by pointing to a “smile” or “frown” face.

Procedures

All components of both sessions took place in a therapy room with a one-way observation window. The room contained a table and three child size chairs. All parts of the session were video recorded using *Landro* video system and a microphone attached to the shirt collar of each child, about 4.5 to 5 inches from their mouth. The clinician was a female graduate student studying speech-language pathology at Duquesne University.

Session 1.

Screening. During the initial individual session, the child first completed a pure tone hearing screening (25 dB HL at 500Hz, 1000Hz, 2000Hz, and 4000Hz), using play audiometry, to confirm that the child’s hearing was within normal limits. This was an important step of the screening process as the child needed to be able to hear oral directions given by the clinician. It was also important to rule out hearing problems as a co-morbidity to any language or fluency problem the child may have experienced. The child was given a pass/fail rating for both the right and left ears by indicating when they heard the tone. If a child failed either one or both ears they were encouraged to see their pediatrician and/or seek a complete audiologic evaluation. All children in the study passed the hearing screening without difficulty.

After the child passed the hearing screening in both ears, the child and their caregiver were led to a therapy room with a one-way observation window. The room contained a table and chairs. The caregiver was instructed to have a conversation with the child, as they normally would, to produce a language sample. The clinician explained that she would be staying in the room to observe, but that they should not let it distract their discussion. If the child had a difficult time maintaining conversation, toys were brought into the room to encourage the child to engage in the session. The clinician remained in the room to observe the interaction so the child became familiar and comfortable with her and interacted with the child if initiated by child/caregiver.

In order to obtain a true sample of the child's speech, in the most natural environment possible (i.e. conversation with their caregiver), a spontaneous conversation was used to obtain the language sample. As stated by Southwood and Russell (2004) "the spontaneous language sample forms an important part of the language evaluation protocol…because of the limitations of standardized language tests, the results of these tests must be supplemented with a spontaneous language sample" (p.366). In other words, the spontaneous language sample is crucial, especially with young children, as it will provide a more accurate reflection of the child's language abilities (Crystal, Fletcher & Garman, 1976; Dollaghan, Campbell, Tomlin, 1990, p.582; Lahey, 1988; Miller, 1981). Only providing data from standardized tests would not be sufficient to properly analyze the child's language abilities. "Spontaneously produced language, constitutes one of the most informative and ecologically valid sources of data on the language production skills of normal and disordered individuals" (Dollaghan, Campbell &Tomlin, 1990, p.582; Lahey, 1988; Lund & Duchan, 1988; Miller, 1981).

It was also important to assess language to confirm that the child had normal language development for their age and did not exhibit a language impairment. If a child who stutters also has a language impairment, their rate of gesturing may not be representative since "children with language impairment have been seen to use gestures at a rate of nearly one and a half times that of their typically developing peers" (Iverson & Braddock, 2011, p.78). They also use more representational gestures than their typical peers, most likely because these gestures do not require accompanying speech to be understood. It is believed that children with language impairment use more gestures as a way of compensating for their "poor oral language" (Iverson & Braddock, 2011, p.81). Children with language impairment may also have gross and fine motor deficits compared to their same age peers. Iverson and Braddock (2011) found that children with language impairment obtained lower fine and gross motor scores on both the *Battelle Developmental Screening Inventory* (Newborg, Stock, Wneck, Guidubaldi & Suinick, 1994) and the *Child Development Inventory* (Ireton, 1992) than their same age peers. Therefore it was important to be aware of these findings and allow only those participants with normally developing language to participate in the study.

In addition to the language sample, the child was evaluated with a standardized assessment in order to verify that the child's language abilities were within normal limits for his/her age.

> Of course all studies of childhood stuttering, whether cross-sectional or longitudinal, can be influenced by contaminating factors – for example, between and/or within-group differences in associated speech-language production abilities (e.g. difficulties with phonological development). Thus, it is important to ensure that all participants in all talker groups (i.e. children who do and do not stutter) meet the same inclusionary criteria (e.g. demonstrate performance within normal limits on standardized tests of articulation, vocabulary, expressive and receptive language abilities, etc) and that both talker groups are closely matched in terms of gender and chronological age." (Pellowski & Conture, 2002, p.21)

In other words, the clinician needed to ensure that all children, typical and those with fluency disorders, fell within the normal range for both speech and language abilities, so that difficulties with sound production and/or language could be ruled out as a possible co-morbidity to the child's stuttering.

Language. The clinician then administered the *Clinical Evaluation of Language Fundamentals – Preschool (CELF-Preschool)* (Wiig, Secord, & Semel, 2004) to assess the child's receptive and expressive language skills. The child needed to score within or above 1 *SD* of the mean to qualify for the study.

Speech production. To conclude the first session, the *Goldman-Fristoe Test of Articulation (GFTA-2)* (Goldman & Fristoe, 2000) was administered to the child to assess his/her speech sound production. The child needed to score within or above 1 *SD* of the mean to qualify for the study.

Child Development Inventory. Before leaving the clinic, each caregiver was given the *Child Development Inventory (CDI)* (Ireton, 1992) to complete prior to the second session. The *CDI* is a 300-item parent questionnaire that covers social, self-help, gross motor, fine motor, expressive language, language comprehension, letters, numbers, and general development. The clinician briefly explained the *CDI* and asked the caregiver to fill it out and bring it to the next session. Although other assessments were completed to examine some of these domains, it was important to broaden view of the child's development by obtaining the caregiver's perspective.

Session 2.

Language sample. During the second session, each participant was led to a therapy room where they sat down across the table from the clinician. The session began by eliciting a language sample from the child. Since this was the child's second visit to the clinic and he/she felt more comfortable with the environment, the clinician engaged the child in spontaneous conversation. Toys were only brought into the room if the child needed them to facilitate a conversation.

Fluency and gesture. After completing the language sample, the caregiver was asked to return to the room and sit next to the child. The clinician sat across the table from the child and caregiver to observe the interaction. The child was then engaged in a cartoon narration task. This task was a replication of the protocol used by Iverson and Braddock (2011) discussed previously. The cartoon narration task was adapted from the *Autism Diagnostic Observation Schedule* (*ADOS)* (Lord, Rutter, DiLavore, & Risi, 1999), and was "specifically designed to press for gesture use" (Iverson & Braddock, 2011, p.76). Although the *ADOS* requires that the pictures be removed from view during the child's retelling, the task was modified for young children to permit the pictures to be visible during the child's retelling of the story. The introduction of an Elmo doll was another modification made by Iverson and Braddock to encourage the child to provide details when retelling the story. Iverson and Braddock stated "we introduced several modifications to reduce memory demands and make the task appropriate for young children" (p.76). Since the children in this study were also similar in age to the participants in the Iverson and Braddock protocol, the same modifications were made in the present investigation. A sequence of six, black, and white drawings were placed in front of the child and their caregiver (Appendix D). The clinician then instructed the caregiver to look at the pictures with the child and talk with them about what was happening in the pictures. The clinician observed this interaction from across the table. Like Iverson and Braddock's procedures, after the child and their caregiver finished talking about the pictures, the clinician brought a stuffed monkey into the therapy room.

The clinician then instructed the child to tell the monkey the story while using the pictures to guide them. This task was important to obtain a more structured language sample to observe the child's disfluencies and use of gestures. As Dollaghan et, al. stated, "narration tasks allow the examiner to impose some constraints and consistency on the topics addressed by the speaker and simultaneously to reduce the variability associated with the examiner's skills as a language elicitor" (Dollaghan, Campbell, & Tomlin, 1990, p.583).

For the third task of this session, the child completed another cartoon narration, this time consisting of a short video clip, without sound from "Mickey's House of Villians" (2002). In this clip, the child watched a witch come to Donald Duck's house with his nephews to get their Halloween treats after Donald gave them fireworks instead. Donald would not give up the key to the closet with the treats, so the witch used her magic to make him give up the key. The clip was exciting for the child to watch but not so exciting that they were unable to produce a narration about the video. The video had a lot of action and did not require audio to understand what was happening. For this task, a laptop computer was brought into the therapy room and placed on a tray table facing the child and clinician. The clinician told the child that they were going to watch a short video. She explained that there was not any sound with the video so they should pay close attention to what they see. The clinician told the child to watch it quietly the first time then they would have an opportunity to tell her about what was going on. She then played the video clip and watched along with the child. After watching the video once, the clinician had the child stand up and explained to the child that she was going to play the video again but this time she wanted them to tell her what was happening as they saw it. This was a replication of Dollaghan, Campbell, and Tomlin's (1990) study in which the children narrated the video clip on-line during the second viewing of the video (p.583). This was a modification, due to the participants' ages, from Tomlin's original 1985 study, in which children provided a narration after watching the video only once (Dollaghan, Campbell, & Tomlin, 1990). The child was requested to tell the clinician as much as possible and encouraged to use their hands if it helped them to tell the story.

This task, a variation of the first cartoon narration task, also introduced a timed environment, which may have put more stress on the child. As stated by Dollaghan et al. (1990) "during the conversation, there are few temporal constraints, and the subject had unlimited time to formulate, revise, and clarify his or her utterances. The video narration task, by contrast, represents a condition in which the subject's language production skills are stressed to an unusual degree; in many cases, the additional processing demands reveal formulation and production difficulties that are not observed in conversation" (p.586). It was hypothesized that this task would stress the language system of typical children as well as those with fluency disorders. The effects of this stress were exhibited in the number and type of disfluencies the child experienced and the number and type of gestures the child used. In addition, the video narration was expected to be a highly engaging task for most children that would in turn elicit more language and use of gestures.

Motor skills. The participant was then engaged by the clinician in the gross and fine motor subtests of the *Battelle Developmental Inventory-2* (*BDI-2*; Newborg, 2004) to assess the child's motor skills. This task took place in a large therapy room. The child was asked to perform a variety of developmentally appropriate gross and fine motor tasks (e.g. kicking a ball, walking backward, catching a ball, grasping a pencil, stringing beads, folding a sheet of paper, etc). This task was important to formally assess the gross and fine motor skills of the child. It also provided information as to where, if anywhere, the child has deficits in their motor system and what stage they are at developmentally.

Procedural Description Narrations. To conclude the session, the participant was asked to stand behind the tray table in the therapy room. The clinician sat next to the child so the camera captured all that the child did during the tasks. A target (i.e. large star), which was used during one of the conditions, was taped onto the table directly in front of the child. The child was then engaged in a series of three short procedural description narration tasks, which required them to produce a story during three different conditions: 1) with restricted use of hands (i.e. holding onto a boomerang), 2) free use of their hands and 3) tapping one hand on a target on the table. The order of the tasks was randomized for each child to avoid fatigue and practice effects. This task allowed for observation of fluency during three different conditions. The third condition was especially important, as those who stutter have been observed to have fluent speech when their speech is timed to a rhythmic beat. This phenomenon has also been observed when a person with a stutter swings their arm to facilitate fluent speech. By having the child tap his or her hand on the table it is hypothesized that they may attach their speech to the rhythm, which may allow their speech to be more fluent.

For each procedural description, the clinician asked the child to provide a short story about each of the following subjects (i.e. how to get dressed, what their room looks like, and how to play baseball). While providing the narration, the clinician instructed them to engage in one of the three motor tasks which the clinician modeled: 1) hands restricted, 2) free use hands, and 3) tapping hand. For each condition the clinician instructed the child to tell them the story while completing one of the motor tasks. The clinician then modeled the condition she wanted the child to engage in. The clinician directed her attention to the child while they told their story. If for some reason the child strayed from the condition they were supposed to be engaging in 1) hands restricted 2) free use of hands and 3) tapping their hand), the clinician provided a model and gentle reminder to engage the child in the correct condition.

Data collected.

Language sample. Mean length of utterance (MLU), a type-token ratio to measure lexical variety, (Templin, 1957), and total words spoken, were calculated from the language samples using *Systematic Analysis of Language Transcripts (SALT)* (Miller & Chapman, 1985), to provide an indication of the children's language proficiency. In addition, a written transcript of the interaction was coded for number and type of disfluencies (stuttering-like or other disfluencies) using *SALT* (See Appendix B) and number and type of gestures (deictic, conventional, representational, and beat) using *EUDICO Linguistic Annotator* otherwise known as *ELAN* (http://www.lat-mpi.eu/tools/elan/) (See Appendix C). Coding gestures was completed by visual inspection of gesture via *ELAN* according to the gestures listed in Appendix C. The child obtained a standardized score based on their age for both the *CELF-P* and the *GFTA.* The standardized score fell within or above 1 *SD* to qualify the child for the study.

Motor skills. The child received a scaled score on the *CDI.* It was predicted that children who experienced a fluency disorder would exhibit more deficits in gross and fine motor skills as reported by their caregiver than peers without a fluency disorder. The child obtained two scaled scores for the *BDI-2,* one for fine motor and one for gross motor. These scores were correlated with frequency of stuttering-like and other disfluencies. The frequency of gestures used in the previous three language tasks (language sample, *ADOS,* and video narration) was also correlated with *BDI-2* scaled scores. It was predicted that children who exhibit more stuttering-like disfluencies would obtain a lower score on the *BDI-2*.

Gestures and disfluencies. In addition to the written transcript produced from the language sample, a transcript was also produced from the adapted *ADOS* cartoon narration and the video narration. Each transcript was then be coded for number and type of gestures (deictic, conventional, representational, and beat gestures) using *ELAN* as well as number and type of disfluencies (stuttering-like and other disfluencies).

Disfluencies during procedural narration. For the procedural description task, transcripts of narrations told during each condition 1) hands restricted (i.e. holding onto a boomerang), 2) free use of hands and 3) tapping their hand on a target on the table, were produced. The transcripts were then be coded for the number and type of disfluencies experienced. It was predicted that typical children would have more disfluencies in the first and third conditions and fewer disfluencies in the second condition. Children with a fluency disorder were expected to have fewer disfluencies in the first and third condition and more disfluencies in the second condition.

*Exploratory data. C*orrelations between the children's performance on the *BDI-2* and *CDI* were analyzed in relation to their gesture use in the cartoon narration and video narration tasks. It was predicted that the lower the child's performance on the *BDI-2* and the *CDI* the lower the frequency would be of gesture use during spontaneous narration.

Data Analysis

Descriptive statistics (means, standard deviations) are provided for all dependent measures. Correlations between motor assessment, data gesture production, and disfluencies were completed using Pearson correlation coefficients. The current limited sample size and data set prohibited completing parametric inferential statistics on the gesture and disfluency production across tasks. Therefore, nonparametric Friedman tests of repeated measures were completed to compare the means of gesture frequency and disfluency frequency across the different language tasks (i.e., spontaneous language sample, ADOS narration, and video narration) and the different hand movement conditions of the procedural description task (i.e., gesture permitted, hands restricted, tapping encouraged).

Reliability was completed for two of the nine participants (22% of the sample) by another graduate student studying speech-language pathology. The student was trained on how to complete the language analysis using *SALT,* the gesture analysis using *ELAN* and Appendix C, and the analysis of disfluencies using Appendix B. The student ratings' of the first participant's disfluencies identification stood out as being different from the examining clinician's observations. A possible reason for this discrepancy is that the child was extremely difficult to understand at times. Certain times during the analysis when the examining clinician could not understand what the participant was saying, the phrase was marked as unintelligible. This occurred ten times in the transcript. When reliability was completed, only four utterances were marked as unintelligible, thus more disfluencies were likely to have occurred during times in the transcript when the examining clinician marked utterances as unintelligible. Results are seen in Tables 3 through 8.

Table 3.
Interrater comparisons of language sample variables.

	MLU	TDW
Rater 1	4.73	172.00
Rater 2	5.11	185.00
Rater 1	3.74	159.00
Rater 2	3.98	163.00

Table 4.
Interrater comparisons of gesture classification for language sample.

	Deictic	Representational	Beat	Conventional	Total
Rater 1	6	0	0	0	6
Rater 2	10	0	2	2	14
Rater 1	9	1	11	54	75
Rater 2	12	1	9	61	83

Table 5.
Interrater comparisons of gesture classification for ADOS.

	Deictic	Representational	Beat	Conventional	Total
Rater 1	2	0	0	0	2
Rater 2	2	0	0	1	3
Rater 1	5	0	0	3	8
Rater 2	6	0	1	4	11

Table 6.
Interrater comparisons of gesture classification for video narration task.

	Deictic	Representational	Beat	Conventional	Total
Rater 1	3	0	0	0	3
Rater 2	3	1	0	0	4
Rater 1	11	2	0	1	14
Rater 2	6	7	1	1	15

Table 7.
Interrater comparisons of disfluency classification for language sample and narration tasks.

	Language Sample			ADOS			Video		
	Typ	Atyp	Tot	Typ	Atyp	Tot	Typ	Atyp	Tot
Rater 1	4	1	5	6	1	7	6	3	9
Rater 2	36	21	57	5	6	11	10	4	14
Rater 1	23	0	23	3	0	3	7	3	10
Rater 2	26	23	49	2	5	7	8	21	29

Table 8.
Interrater comparisons of disfluency classification for procedural description task.

	Free Gesture			Restricted			Tapping		
	Typ	Atyp	Tot	Typ	Atyp	Tot	Typ	Atyp	Tot
Rater 1	1	0	1	4	1	5	2	0	2
Rater 2	0	0	0	4	2	6	0	0	0
Rater 1	2	1	3	2	0	2	3	0	3
Rater 2	3	2	5	2	0	2	3	0	3

Results

Participant Characteristics

Speech and language skills of each participant were within age expectations as shown in Table 9. The one child's *MLU* that was not within normal limits for their age, was due to lack of cooperation rather than difficulties with language. Measures of *MLU* (*M* = 5.71, *SD* = 1.55) and total words (*M* = 755.56, *SD* = 306.94) were calculated from the combined language samples collected at the beginning of sessions one and two. The children's standardized scores on the *GFTA-2* (*M* = 107.44, *SD* = 8.89) and the *CELF- P* (*M* = 108.56, *SD* =9.58) were within normal limits as a group and also for each individual child.

Table 9.
Characteristics of Participants.

	sex	**age in months**	***MLU***	**total words**	***GFTA-2***	***CELF-Preschool***
001	M	64	5.58	604	98	106
002	M	48	4.16	519	110	100
003	F	47	4.73	445	123	133
004	F	80	4.76	604	106	106
005	F	64	7.03	1134	112	104
006	F	79	7.19	981	107	108
007	M	46	3.74	375	106	106
008	F	66	8.39	1169	113	110
009	F	62	5.77	969	92	104

GFTA = Goldman Fristoe Test of Articulation -2
CELF-Preschool = Clinical Evaluation of Language Fundamentals - Preschool

Frequency and Type of Gestures in Language Tasks

The number of gestures produced in the language sample, *ADOS*, and video narration were converted to a frequency measure to account for the different temporal durations of the samples for each child. This frequency of gestures per minute measure was computed by dividing the total number of gestures observed in each task by the length of time (in minutes) for each sample yielding a frequency of gestures per minute metric. Refer to Table 10 for the length for each sample.

Table 10.
Temporal data in minutes for language sample, ADOS, and video narration.

Participant	Language Sample	*ADOS*	Video Narration
001	7	2.80	4.93
002	14.33	0.95	3.17
003	7	1.72	3.63
004	15	0.75	3.75
005	15	1.75	3.86
006	15	1.10	3.32
007	15	1.20	3.75
008	15	0.48	3.88
009	11.62	0.70	3.87

Language sample. As seen in Figure 1, conventional gestures (M = 1.47, SD = 1.27) were the most frequently observed gesture during the language sample. This is an unexpected finding and most likely due to the fact that head nods were coded as conventional gestures as classified by Iverson and Braddock (2011). Representational gestures (M = 0.90, SD = 0.80) were the second most frequently observed gesture. It is not surprising that representational gestures were observed frequently during the language sample, which is the best measure of the child's language abilities, as children this age tend to use iconic gestures more than other types of gestures, referring to Table 11 for raw data. The next most frequently observed gestures were beat gestures (M = 0.59, SD = 0.65) and then deictic gestures (M = 0.32, SD = 0.28). Both of these findings are surprising as preschool-aged children do not often use beat gestures, but often do use pointing or deictic gestures (McNeill, 1992).

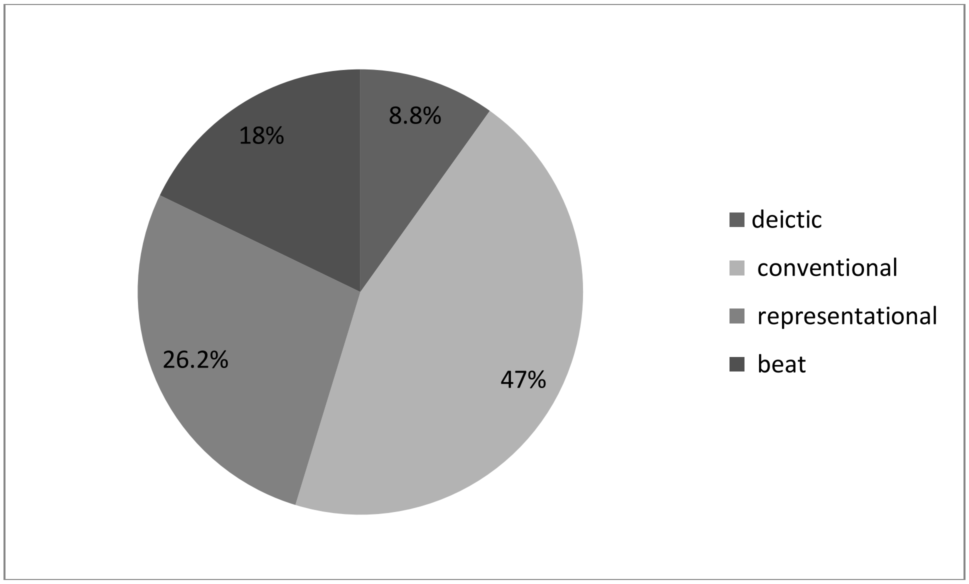

Figure 1. Frequency (gesture per minute) and type of gesture seen in language sample.

Table 11.
Number and type of gestures observed in language sample.

	Deictic	Conventional	Representational	Beat	Total
001	0	8	14	3	25
002	5	2	1	0	8
003	6	0	0	0	6
004	3	49	22	2	76
005	2	14	22	1	39
006	1	32	28	13	74
007	9	54	1	11	75
008	3	14	10	29	56
009	6	13	6	13	38

Autism Diagnostic Observation Schedule. As seen in Figure 2, the most frequently observed gestures during the *ADOS* were deictic gestures (M = 2.73, SD = 2.91), which is understandable as the children often pointed to characters in the cartoon pictures while telling the story. The second most frequently observed gesture were beat gestures (M = 1.73, SD = 4.23). Again this is a surprising finding as research has shown that preschool children do not often use beat gestures (McNeill, 1992). The third and fourth most frequently observed gestures were conventional gestures (M = 0.46, SD = 0.85) and representational gestures (M = 0.44, SD = 0.88), as seen in Table 12.

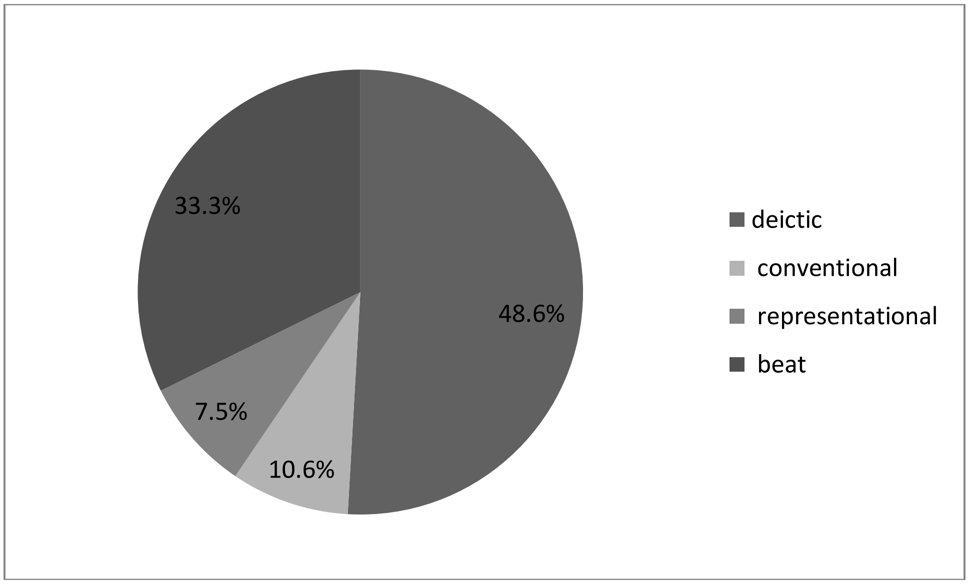

Figure 2. Frequency (gesture per minute) and type of gesture seen in *ADOS*

Table 12.
Number and type of gestures observed in ADOS.

	Deictic	Conventional	Representational	Beat	Total
001	3	3	2	8	22
002	9	0	0	0	9
003	2	0	0	0	2
004	2	0	2	0	4
005	2	1	1	0	4
006	3	0	0	14	17
007	5	3	0	0	8
008	0	0	0	0	0
009	0	0	0	0	0

Video narration. During the video narration, deictic gestures (M = 0.60, SD = 0.95) were observed the most frequently as a function of time, as seen in Figure 3. This was due to the fact that the child often pointed to actions occurring during the video they were narrating. Representational gestures (M = 0.21, SD = 0.30) were the second most frequent gesture type. Since the video contained a lot of action, sometimes the child demonstrated the action while describing it. The last type of gestures observed during the video narration were conventional gestures (*M* = 0.12, *SD* = 0.27). Only one participant used beat gestures during the video narration. Since the participant only used two beat gestures, the frequency is not enough to show up in the pie chart. Refer to Table 13 for raw data.

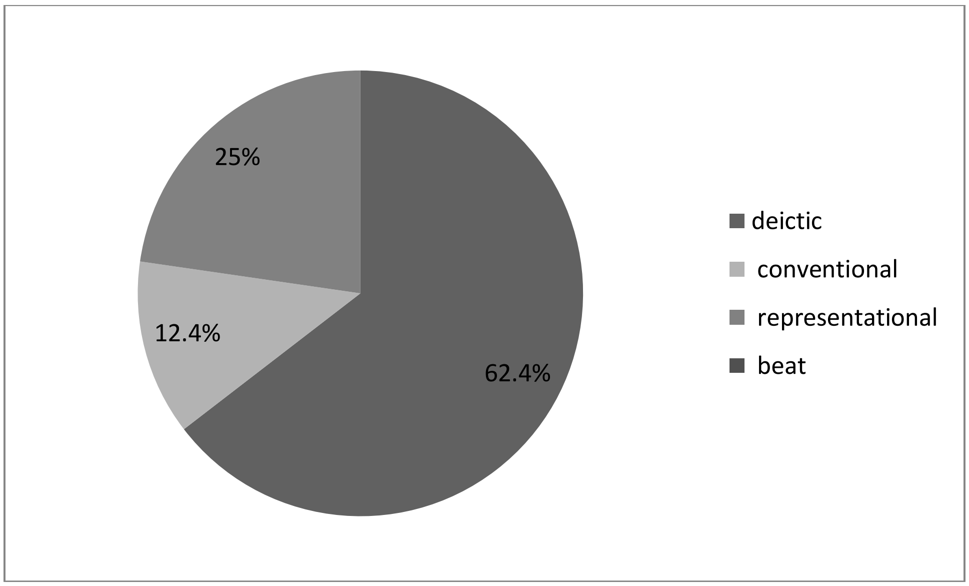

Figure 3. Frequency and type of gesture seen in video narration.

Table 13.
Number and type of gestures observed in video narration.

	Deictic	Conventional	Representational	Beat	Total
001	2	0	4	0	6
002	3	0	0	0	3
003	3	0	0	0	3
004	0	3	0	0	3
005	0	0	0	0	0
006	1	0	1	0	2
007	11	1	0	2	14
008	0	0	0	0	0
009	0	0	1	0	1

Summary of gesture frequency across language tasks. As seen in Figure 4, across the three tasks (i.e., language sample*, ADOS* cartoon narration, and video narration), gestures were observed with the most frequency during the *ADOS* narration task (M = 5.36, SD = 5.14), followed by the language sample (M =3.29, SD = 1.69), and then the video narration (M = 0.93, SD = 1.13). Friedman test revealed a significant effect of language task on frequency of gesture ($\chi^2(2)=7.60$, $p < 0.022$).

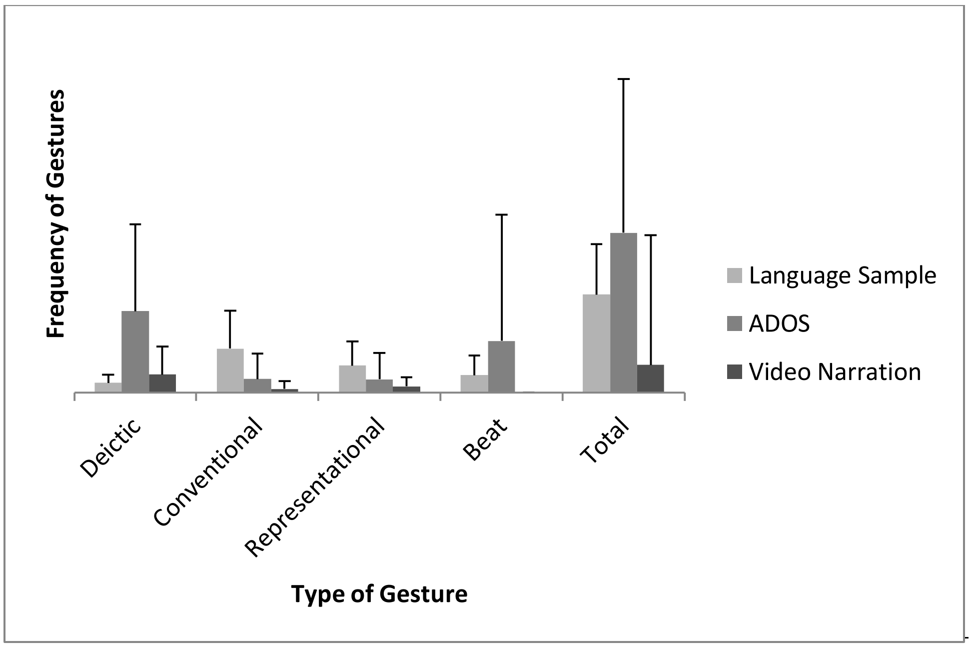

Figure 4. Frequency per minute and type of gestures across language sample, ADOS, and video narration. Error bars correspond to one standard deviation.

Frequency and Type of Disfluencies across Language Tasks

Language sample. Typical disfluencies (M = 3.47, SD = 2.78) were observed at a higher frequency per minute compared to atypical disfluencies (M = 0.27, SD = 0.56) during the language sample as depicted in Figure 5. This was expected as all participants were typically developing preschoolers who should mainly produced typical disfluencies, rather than atypical disfluencies. This was also expected given that the language sample is the most natural and spontaneous context given that the samples were also elicited by caregiver and/or clinician. Refer to Table 14 for raw data on typical and atypical disfluencies.

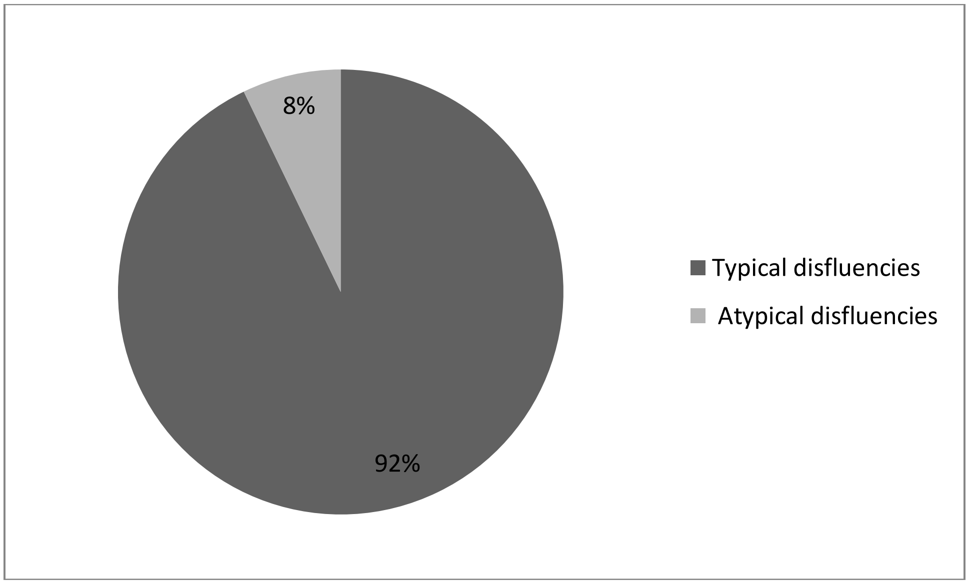

Figure 5. Frequency per minute and type of disfluencies seen in language sample.

Table 14.
Number and type of disfluency observed in language sample, ADOS, and video narration.

	Language Sample			ADOS			Video			Total		
	Typ	Atyp	Tot	Typ	Atyp	Tot	Typ	Atyp	To t	Typ	Atyp	Tot
001	40	0	40	5	0	5	5	0	5	50	0	50
002	61	0	61	4	7	11	5	2	7	70	9	79
003	4	1	5	6	1	7	6	3	9	16	5	21
004	26	1	27	3	6	9	7	0	7	36	7	43
005	82	26	108	10	0	10	29	3	32	121	29	150
006	12	2	14	1	1	2	13	0	13	26	3	29
007	23	0	23	3	0	3	7	3	10	33	3	36
008	132	5	137	3	1	4	2	0	2	137	6	143
009	27	0	27	0	0	0	1	1	2	28	1	29

Autistic Diagnostic Observation Schedule. As seen in Figure 6, during the *ADOS*, children had a higher frequency of typical disfluencies per minute (M = 2.74, SD = 1.79) as compared to atypical disfluencies (M = 1.13, SD = 2.60). However, children did exhibit more atypical disfluencies during the *ADOS* narration than they did in the language sample. This may be due to the fact that the children were required to tell a narration in a constrained context based on the cartoon pictures presented to them.

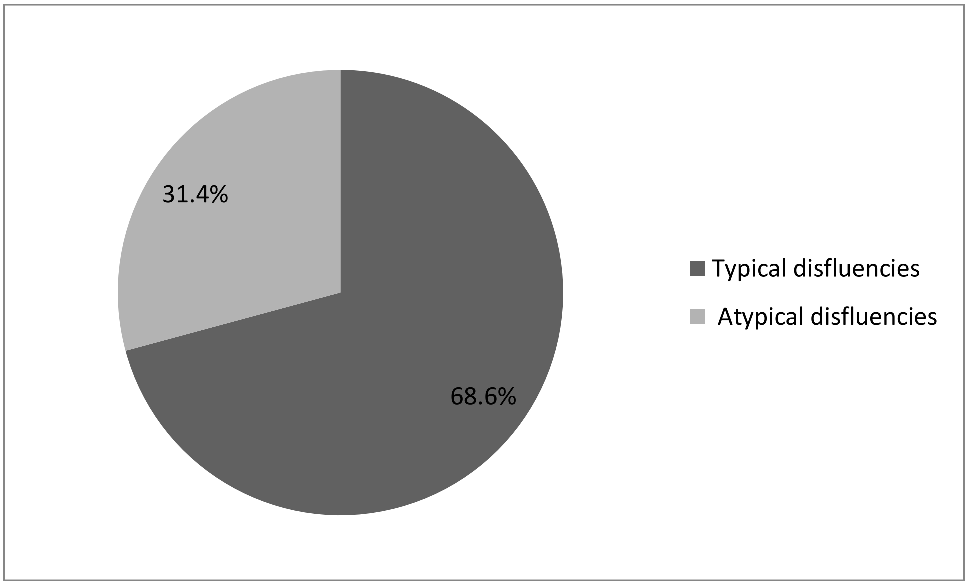

Figure 6. Frequency per minute and type of disfluencies seen in *ADOS.*

Video narration. As seen in Figure 7, children experienced a higher frequency per minute of typical disfluencies (*M* = 2.24, *SD* = 2.24) than atypical disfluencies (*M* = 0.37, *SD* = 0.39) during the video narration. However, similar to the frequency disfluencies produced during the ADOS task, a higher proportion of atypical disfluencies was observed relative to the more natural language sample task. This may be due to the completion of the narration within a specified amount of time and the fact that the child had to keep up with the video while providing the narration.

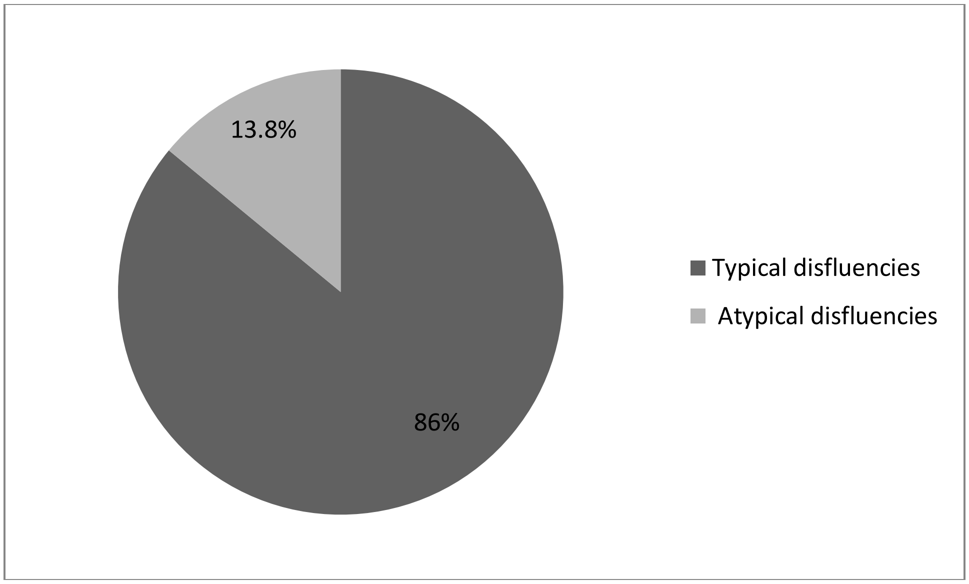

Figure 7. Frequency per minute and type of disfluencies seen in video narration.

In respect to disfluencies observed across the tasks, children had the most disfluencies as a function of time during the *ADOS* cartoon narration (M = 4.69, SD = 4.33), followed by the language sample (M = 3.73, SD = 3.02), then the video narration (M = 2.61, SD = 2.40), as seen in Figure 8. Overall the children experienced more typical disfluencies during the language sample (M = 3.47, SD = 2.78), followed by the *ADOS* cartoon narration (M = 2.74, SD = 1.79), and then the video narration (M = 2.24, SD = 2.24). The most atypical disfluencies were observed during the *ADOS* cartoon narration (M = 1.13, SD = 2.60), followed by the video narration (M = 0.37, SD = 0.39), and then the language sample (M = 0.27, SD = 0.56). Friedman test revealed a nonsignificant effect of language task on frequency of disfluencies ($\chi^2(2)=.222$, $p < 0.89$).

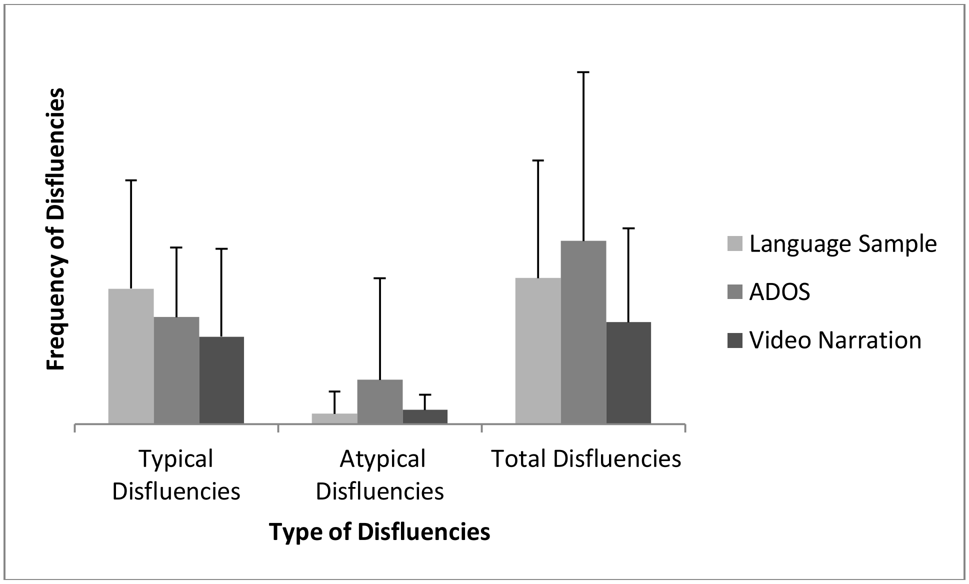

Figure 8. Frequency and Type of Disfluencies across language sample, *ADOS* cartoon narration, and video narration tasks. Error bars correspond to one standard deviation.

Frequency and Type of Disfluencies during Procedural Description Tasks

During the procedural description tasks, children experienced more typical disfluencies when their hands were restricted from use (*M* = 3.78, *SD* =3.04), followed by the tapping condition (*M* = 3.45, *SD* =3.76), then the free use of their hands (*M* = 2.16, *SD* =2.40), refer to Table 15 for raw data. Children experienced more atypical disfluencies during the tapping condition (*M* = 0.62, *SD* = 0.99), followed by when hands were restricted (*M* = 0.41, *SD* = 0.67), then during free use of hands (*M* = 0.34, *SD* = 0.89). Overall, as predicted children experienced the most disfluencies during the condition in which their hands were restricted from use (*M* = 4.18, *SD* =3.34), followed by the tapping condition (*M* = 4.08, *SD* = 4.70), then by free use of hands (*M* = 2.50, *SD* =3.03). Friedman test revealed a significant effect of condition of the procedural description task on frequency of disfluencies ($\chi^2(2)=6.89$, $p < 0.032$).

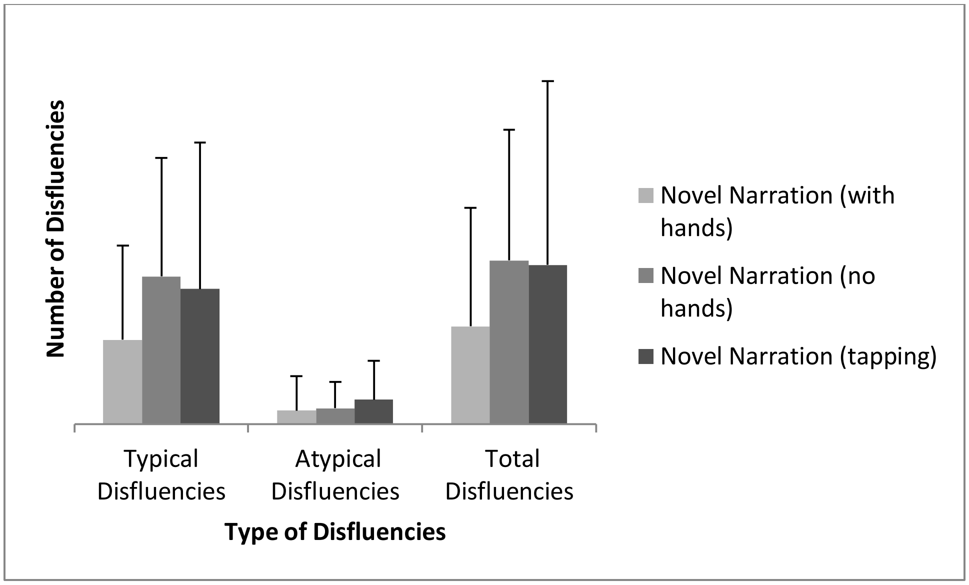

Figure 9. Frequency and type of disfluencies across procedural description tasks. Error bars correspond to one standard deviation.

Table 15.
Number of disfluencies seen in procedural description tasks.

	With hands			Hands restricted			Tapping			Total		
	Typ	Atyp	Tot	Typ	Atyp	Tot	Typ	Atyp	Tot	Typ	Atyp	Tot
001	12	0	12	7	0	7	5	1	6	24	1	25
002	10	0	10	8	1	9	11	3	14	29	4	33
003	1	0	1	4	1	5	2	0	2	7	1	8
004	3	0	3	7	2	9	5	1	6	15	3	18
005	7	3	10	18	0	18	13	3	16	38	13	51
006	2	0	2	4	0	4	1	0	1	7	0	7
007	2	1	3	2	0	2	3	0	3	7	1	8
008	1	0	1	13	5	18	0	0	0	14	5	19
009	2	0	2	2	0	2	3	0	3	7	0	7

Motor Skills

The gross and fine motor skills of each participant were also measured using the *BDI-2* and the *CDI*. The scaled scores of both the *BDI-2* and *CDI* can be seen in the Table 16 as compared to the child's age in months. Since only two of the three motor subtests were completed for the *BDI-2,* a standard score could not be produced. Instead, the scaled scores are presented for each subtest. The scaled score is a norm-referenced with a range of 1-19, a mean of ten, and standard deviation of three. The *CDI*, fine and gross motor scales both have a range from 1-30, on scores based on norms from children one to six years, three months. Based on these scaled scores for both the *BDI-2* and *CDI* all participants appeared to be within normal limits for both gross and fine motor skills. Most participants' gross and motor scores were within a point or two of each other on the *BDI-2*. Only two participants had a difference of four points between their gross and fine motor skills. It must be noted that two participants were 6;6 and 6;5 years respectively, which is above the norm-referenced scores for both the *BDI-2* (5;11 years) and the *CDI* (6;3 years). Due to these limitations, both participants reached or came very close to reaching the ceiling in both tests.

Table 16.
BDI-2 and CDI scaled score compared to chronological age (months).

	sex	**age in months**	***BDI* – gross motor**	***BDI* – fine motor**	***CDI* – gross motor**	***CDI* – fine motor**
001	M	64	9	10	25	30
002	M	48	14	15	27	27
003	F	47	15	13	26	25
004	F	80	10	14	30	30
005	F	64	14	13	27	30
006	F	79	17	14	28	30
007	M	46	15	11	28	23
008	F	66	11	10	25	29
009	F	62	11	11	28	30
M			12.89	12.33	27.11	28.22
SD			2.71	1.87	1.62	2.64

***BDI* fine motor skills versus gestures**. Given the small sample size and data set, all correlational data presented is only exploratory and offers potential insight for future larger scale investigations. The relationship of frequency of gestures per minute and fine motor abilities, based on the *BDI* scaled scores for each participant was examined (r = -0.30, p = 0.43). As can be seen in Figure 10, these two factors have a negative correlation, though not a significant one. In other words, this small data set suggests that as a child's fine motor abilities increase, their gesture use may decrease.

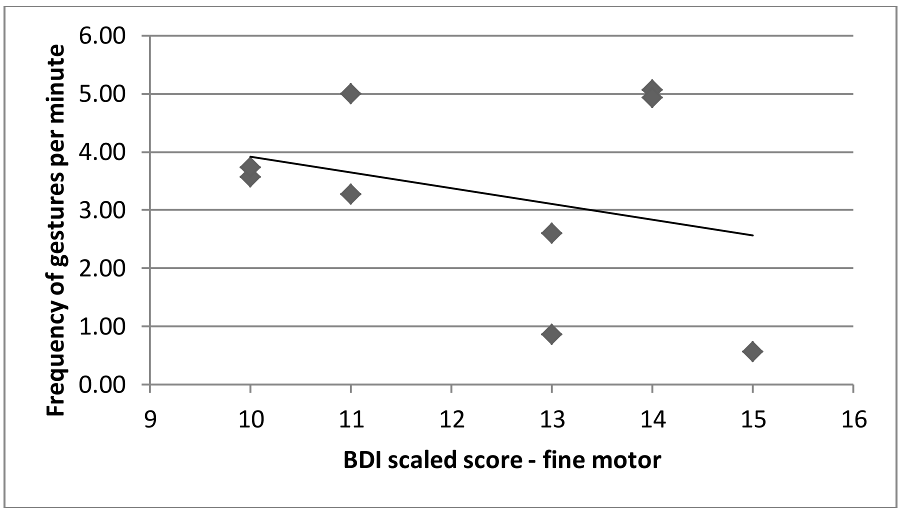

Figure 10. Frequency of gestures per minute versus *BDI* fine motor scaled score.

Fine motor skills versus disfluencies. A negative correlation between the frequency of disfluencies per minute during the language sample and their *BDI* fine motor scaled score (r = -0.41, p =0.27) was calculated as shown in Figure 11. Though not significant, lower *BDI* fine motor scaled scores correlated with increased disfluencies.

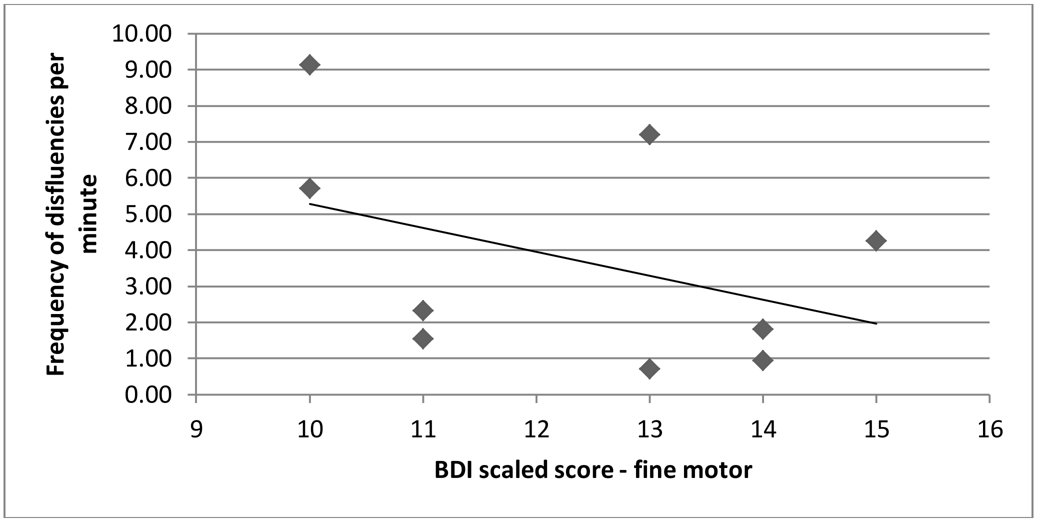

Figure 11. Frequency of disfluencies per minute versus *BDI* fine motor scaled score.

Frequency of Gestures versus Frequency of Disfluencies

A negative correlation was observed between the frequency of disfluencies per minute versus the frequency of gestures during the language sample (r = -0.13, p =0.74) was calculated as shown in Figure 12.

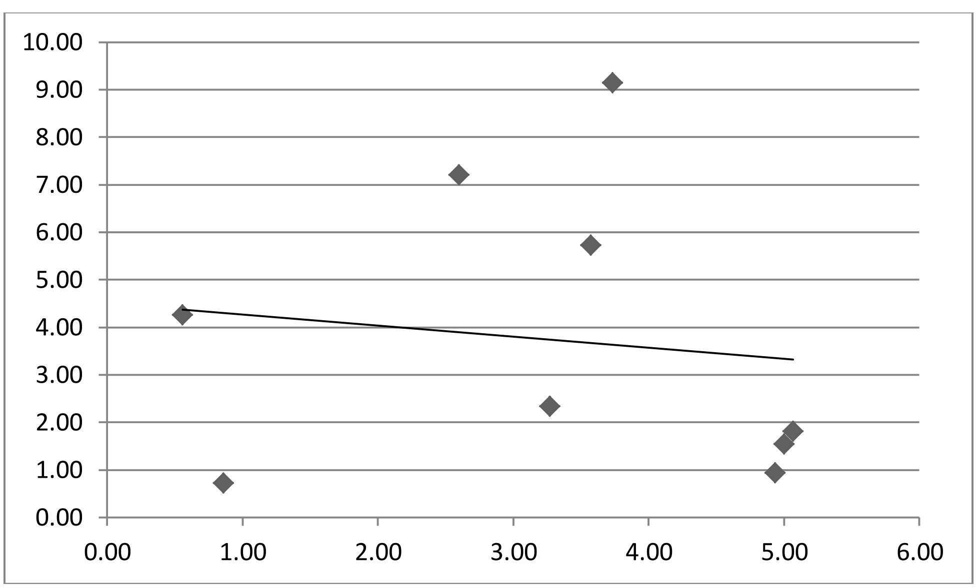

Figure 12. Frequency of gesture production versus frequency of disfluencies observed during the language sample.

Conclusion

In conclusion, out of the three language tasks (language sample, *ADOS,* and video narration) preschool children used the greatest frequency of gestures per minute during the *ADOS* cartoon narration. They used the lowest frequency of gestures per minute during the video narration. During the language sample, the gestures used with the most frequency were conventional gestures and deictic gestures were used the least. During the *ADOS,* deictic gestures were used with the most frequency and representational gestures with the least frequency. During the video narration, deictic gestures were used with the most frequency and beat gestures were only used by one participant.

Children experienced the greatest frequency of disfluencies per minute during the *ADOS* cartoon narration and the lowest frequency of disfluencies during the video narration. During procedural description tasks, children experienced the greatest frequency of disfluencies when their hands were restricted from use, followed by the tapping condition, and then free use of their hands.

Though not significant, fine motor skills as examined by the *BDI-2* had a negative correlation with both frequency of gestures and disfluencies. Likewise, the frequency of gestures also had a small negative correlation with frequency of disfluencies during the language sample.

Discussion

The initial predictions of the study are presented below. However, it is important to note that only typically developing participants were assessed. Thus, no comparisons will be made between groups. However, the gesture, motor skills, and disfluencies of typically developing children were assessed.

Gestures

1) Preschoolers who stutter will use fewer gestures compared to their same age peers during spontaneous speech, cartoon narration, and video narration tasks.

Previous research that has examined gesture development and production in preschool children, though sparse, consistently demonstrated that children's first gestures are deictic or pointing gestures, used to express interest in objects (Goldin-Meadow, 2003; Capone & McGregor, 2004). Gesture development continues with representational (iconic) gestures, as the next gesture type to be added to the child's repertoire (Capone & McGregor, 2004; Goldin-Meadow, 2003; McNeill, 1992). At an undetermined time after the development of these two types of gestures, beat gestures begin to emerge. Gesture development then continues through adolescence and eventually adults begin to use beat gestures as an integral part of their communication. This study attempted to fill in some of the gaps as to when and how children use different types of gestures in their communication in different language tasks (i.e., language sample, *ADOS narration,* and video narration) as described by Iverson and Braddock (2011) (See Appendix C). As a function of time, gestures were produced on average with the greatest frequency during the *ADOS* narration task, followed by the language sample and then the video narration.

Considering that the *ADOS* cartoon narration is a task designed to press for gestures (Iverson & Braddock, 2011), it is not surprising that children used more gestures during this task than during the language sample or video narration. It is important to note though, that the cartoon pictures were visible to the child, following adaptations used in Iverson & Braddock (2011), so the majority of the gestures observed were deictic gestures. It is not surprising that children used more gestures during the *ADOS* than the language sample as research has shown that ten year olds gesture more than six year olds and adults gesture more than both groups of children (Colleta, Pellenq, & Guidetti, 2010). Thus, if gesture use increases with age, preschool children should not be expected to use a large number of gestures during spontaneous speech. It is interesting however, that children did not gesture more during the video narration when they were under a time constraint, as their language systems were stressed and additional processing demands were placed on the child (Dollaghan, Campbell & Tomlin, 1990). It is notable that participants did not use additional gestures in order to ease the stress placed on their language systems.

Deictic gestures.

Deictic gestures were observed the most frequently during the *ADOS* cartoon narration followed by the video narration. Though this data was unexpected, it makes sense as children had a picture in front of them to reference during their story. If the visual aids were taken away it is expected the children would have used fewer deictic gestures because they would not have any pictures to reference.

Conventional gestures.

Conventional gestures were observed most frequently during the language sample, followed by *ADOS,* and then the video narration. It is important to point out that in this study conventional gestures included nodding the head yes, which some researchers may not include as a gesture. Head nodding was included as the gesture classification system was a previous classification system used by Iverson and Braddock (2011) and adopted for this study. This most likely accounts for why conventional gestures were seen with such frequency in the language sample. Future analyses of the data could exclude non-manual gestures and future investigations could eliminate non-manual gestures in the data extraction process.

Representational gestures.

Representational gestures were seen with the most frequency during the language sample (i.e. throwing something, imitating a cartoon character), followed by the *ADOS (i.e. taking the fish, bird flying away),* and then the video narration (i.e. hiding the key, a witch flying on a broom). It was expected that children would use these gestures with a high frequency as they are a common gesture used during the preschool years.

Beat gestures.

Beat gestures were surprisingly observed the most during the *ADOS,* followed by the language sample. Since the *ADOS* was a more structured task with specific parts of the story that needed to be told, perhaps the beat gestures helped the child to retrieve the specific word that they wanted to use, whereas in the language sample they could use any word they wanted to. It is important to note that beat gestures were not observed at all during the video narration. A lower frequency of beat gestures was expected across tasks as beat gestures are typically found more often in adult populations rather than in children.

Motor Abilities

2) Children who stutter will exhibit more motor deficits on the *Battelle Developmental Inventory-2* and *Child Developmental Inventory* relative to their same age peers.

This question could not be assessed as due to recruitment limitations , though participants did exhibit typical motor skills as expected.

Disfluencies

Although there is no data for children who stutter in this study due to recruitment difficulties, it was still important to observe the disfluencies of typical developing preschoolers. In respect to disfluencies observed across the tasks, children had the greatest frequency of disfluencies as a function of time during the *ADOS* cartoon narration, followed by the language sample, then the video narration, as seen in Figure 8. Overall the children experienced more typical disfluencies during the language sample, followed by the *ADOS* cartoon narration, and then the video narration. The highest frequency of atypical disfluencies was observed during the *ADOS* cartoon narration, followed by the video narration, and then the language sample. It was expected that the children would have more atypical disfluencies during the video narration as they were required to produce the narration within a specified amount of time. However, more atypical disfluencies were observed during the *ADOS*. It is not surprising that more disfluencies were observed in the *ADOS* and video narration compared to the language sample, as the child's language system was potentially challenged more in these tasks than in the spontaneous language sample (Campbell & Dollaghan, 1995).

3) Children who stutter will experience more disfluencies when encouraged to use their hands while sharing a procedural descriptions.

This question is not relevant because there were not any participants who stuttered.

4) Children who stutter will experience fewer disfluencies when they are not using their hands (as in gestures) as well as during the hand tapping task while sharing a procedural description

This question is not relevant because there were not participants who stuttered.

5) Children who do not stutter will experience more disfluencies when they are not using their hands (as in gesture) as well as during the hands tapping task, and fewer disfluencies when they were encouraged to use their hands while sharing a procedural description.

Children experienced the greatest frequency of disfluencies in the condition with their hands were restricted. This is most likely due to the fact that the child could not use their hands to facilitate their language normally. When they were unable to use their hands they often were disfluent, most likely due to the fact that their hands were unable to help facilitate their spoken language. A similar phenomenon was seen in a study by Pine, Bird, & Kirk (2007). This study examined the effects of prohibiting gestures on children's lexical retrieval ability. They observed that children were able to resolve a "tip of the tongue" state on 75% of occasions when allowed to gesture (p. 750). However, when children were restricted from gesturing, they were only able to resolve "tip of the tongue" states on 46% of occasions (p. 750). Frick-Horbury & Guttentag (1998) also completed a study observing "tip of the tongue" states, this time with adults. Data showed that participants who were restricted from gesture retrieved fewer words in response to word definitions than those participants who were free to gesture (p. 53). This research provides a possible rationale as to why children may predictably have more disfluencies when their hands were restricted from gesturing.

A greater frequency of disfluencies was also observed when the child was asked to continuously tap their hand during a procedural discourse task. Since tapping one's hand while speaking is an unnatural thing to do, especially for a preschool child, more of their thought was put into making their hand tap rather than their spoken language production, potentially resulting in more disfluencies secondary to the distraction of the task requirements.

6) Throughout the three conditions, children who stutter will experience more disfluencies relative to their same age peers.

This question is not relevant as there were not any children who stutter involved in the study.

Relationship between gestures, motor abilities, and disfluencies.

The relationships between the dependent measures were explored in this relatively small sample and resultant data set. The relationship between gesture frequency in the language sample was neither significantly correlated with the frequency of gestures in the language sample, nor with the *BDI* fine motor scaled score. Also, the relationship between the frequency of disfluencies in the language samples and the *BDI* fine motor scaled score was also not significant. However, theoretical postulation, prior empirical work, and the current data suggest continued investigation of the interaction between gestures, disfluencies, and motor skills should be encouraged. Previous studies have indicated that children who stutter, may have a deficits in motor abilities as they are not able to complete complex motor tasks as quickly as their typical peers (Crodd, 1978; Cross & Luper (1983); Olander, Smith, & Zelaznik (2010). Other studies have examined how disfluencies and gestures interact, but have not examined motor skills (Mayberry, Jaques, & DeDe (1998). Furthermore, Iverson and Braddock (2011) examined gesture and motor skills but not disfluencies in children with or without language impairment. Thus, future investigations may elucidate the interaction of these three dependent variables and may offer insight on the theoretical links and clinical implications of gesture production, motor skills, and specifically atypical disfluencies within an individual.

Significance of Project

This study is significant because all three variables were measured so that interactions between them could be investigated. While this study is only exploratory and does not directly ascertain an interaction between these three variables, it has allowed observations of the variables and the opportunity to conjecture about possible relationships.

Limitations/Directions for Future Research

The first limitation of this study was the inability to recruit children who stutter, thus completely changing the focus of the study. Children who stutter offer an interesting perspective on the interaction between motor abilities, gesture use, and disfluencies as there are questions concerning a possible motor deficit. A direction for future research is an examination of the relationship between these variables in children who stutter compared to typically developing children. A closer look at these variables may provide insight into differences found between those children who stutter compared to children who do not stutter. In addition, many children who begin to stutter eventually recover while others continue to stutter throughout their lives. Currently it is unknown why some children recover while others persist in their stuttering. Perhaps if motor deficits are found in some children, these variables could potentially be predictors of persistence versus recovery in stuttering.

In addition to the small sample size and difficulty with recruitment, several other methodological limitations may have affected the results. For instance one of these limitations was that not all tasks were led by the clinician. In the future all tasks should be led by the clinician so that each child is given the same prompts when eliciting the narrations. This may be difficult to complete if the child refuses to be separated from their caregiver, but it is important to keep the study as controlled as possible. Shorter sessions (i.e. one hour maximum) should also be considered, so that the child does not become tired and need to be persuaded to participate. Most young children would be more cooperative and engage more with the clinician if sessions were less than 90-120 minutes in length.

Only completing one of the two *ADOS* cartoon narrations was also a limitation for the study. The *ADOS* narration was the shortest narration completed during the study. For this reason, both cartoons of the *ADOS* should be presented in future research. During the *ADOS* narrations, the child should be encouraged to continue the story for a longer period of time, as this task was much shorter than both the language sample and video narration.

Conclusion

In conclusion, it is important to continue research in the area of gestures in the preschool population. The development of gestures needs to be more closely examined in typically developing children in order to understand gesture use in disordered population. More research also needs to be completed concerning the interaction of motor skills, gestures, and disfluencies. Insight into gestures, disfluencies, and motor skills has much to offer and research needs to continue to investigate questions relating to the interaction between them. When the interaction of gestures and language, as well as the development of gestures is better understood, the robust period of speech and language growth will be better understood.

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Appendices

Appendix A

Fluency, gesture use and fine and gross motor abilities of preschool children.

Thank you for calling the Duquesne University Speech, Language, and Hearing Clinic in response to our search for children ages 3-6 to participate in our study about children with and without fluency disorders. We would like to invite you and your child to take part in a study of fluency, gesture use and motor skills in 3-6 year old children with and without a fluency disorder. The overall objective of this study is to observe the gesture use and motor abilities of children who do and who do not stutter.

Individuals eligible for the study include:
1) Either children between the ages of 3 and 6 years old, who have been diagnosed with a fluency disorder.
--or--
2) Children between the ages of 3 and 6 years old, who experiences significant stuttering behaviors on a daily basis and whose primary caregiver implicitly or explicitly express concern about the child's fluency.
--or—
3) Children between the ages of 3-6 years old, with no history of speech, language, or fluency problems.

If you are eligible and agree to participate in this study, your child will receive speech, language, and hearing evaluations which will require two 1 ½ hour sessions at the Duquesne University Speech, Language, and Hearing Clinic. During the sessions your child will interact with their caregiver during various activities in which they will play and tell stories. They will also interact with a graduate student studying speech-language pathology who will administer speech, language, and hearing tests as well as a short assessment of your child's gross and fine motor abilities.

1) How old is your child?

2) Has your child had a normal development thus far?
Significant birth history?
History of ear infections?

3) How would you describe your child's speech?

4) Does your child experience stuttering in their speech?
If so, about how long has this been occurring?
What kinds of stuttering do they experience? (provide examples of repetitions: of sounds, parts of words, words; pauses)
If so, has your child received treatment to address a fluency disorder?

Describe the frequency, duration, location, and other relevant information about their treatment.

5) Is there any history of stuttering or other language problems in your family?
What types of problems have other family members experienced?

6) Has your child ever been treated for speech or language issues?
If so, what were they treated for?
How long were they treated for?
Are they still being treated?

7) Does your child have any motor, neuromotor, or behavioral problems that you are concerned about?
Has the child ever been seen by an OT or PT?

8) Is your child a native English speaker?
Are there any other languages spoken in the home?

Appendix B

Type of Disfluency	Description	Example
Stuttering-like dysfluency (atypical disfluencies)		
Part-Word repetition	Repetitions of sounds or syllables of words	"mi-milk",
Single-Syllable word repetition	Repetition of an entire single syllable word	"I…I want that"
Disrhythmic phonation	Sound prolongation and blocks	"I have sssssssix cousins"
Tense Pause	Break in sound during which the person is applying pressure to articulators in order to try and force the sound out.	"Can I have some more (lips together; no sound) milk?
Other Disfluencies (typical disfluencies)		
Polysyllabic word repetition	Repetition of a word with multiple syllables	"Swimming …swimming is my favorite activity."
Phrase repetition	Repetition of part of a phrase within a larger phrase	"I was…I was going"
Interjection	Unnecessary word within the phrase	"uh", "er", "well"
Revision-incomplete phrase	Revising a phrase before moving on with the thought.	"I was – I am going", "She was-and after she got there he came"

Bloodstein & Ratner, 2008 (p.5)
Guitar, 2006 (p.140-142)

Appendix C

Type of Gesture	Description	Examples
Deictic gestures	Indicate referents in the immediate environment	Pointing at an object or person; holding up an object for another to see
Conventional gestures	Contain meaning recognizable by others even in the absence of accompanying language	Waving “bye-bye” Nodding the head “yes”
Representation gestures	Depict a characteristic of or action performed by a referent	Flapping arms to refer to a bird flying
Beat gestures	Formless movements of the hands and arms that follow the rhythm of accompanying language, highlighting aspects of discourse structure but conveying no semantic information	Flicking hand up and down or back and forth

Iverson & Braddock, 2011

Appendix D

Sample *ADOS* stimulus